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(54) Name of invention A self-diagnosis and fail-safe device of a water temperature detection circuit in internal combustion engine.

(21) Utility model application S59-184323

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SPECIFICATION

1. Title of the Utility Model

A self-diagnosis and fail-safe device of a water temperature detection circuit in internal combustion engine.

2. Claims for the Utility Model

A self-diagnosis and fail-safe device of a water temperature detection circuit in an internal combustion engine comprising a water temperature sensor disposed so as to be opposed to an engine cooling water passage for generating an electric signal in accordance with a water temperature, and water temperature reading means for reading the water temperature in response to the signal from the water temperature sensor, the water temperature being detected to be utilized for various controls, and further comprising change amount calculating means for calculating a change amount per hour in the read water temperature, determining means for comparing the change amount with the specified value to determine whether or not there is an abnormality, self-diagnosis abnormality display means for displaying a self-diagnosis abnormality when there is an abnormality, and tentative water temperature setting means for setting a tentative water temperature based on the water temperature of the previous time when there is an abnormality and for sending the tentative water temperature to the control section.

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3. Detailed Description of the Utility Model

(Field of Industrial Application)

The present utility model relates to a water temperature detection circuit for detecting an engine cooling water temperature (hereinafter, referred to as a water temperature) in an internal combustion engine, so as to execute various controls such as correction in fuel injection amount based on the detected water temperature, and specifically, relates to a self-diagnosis and fail-safe device thereof.

(Prior Art)

Conventionally, in an internal combustion engine, a water temperature sensor utilizing a thermistor is provided on an engine cooling water path. A signal from the water temperature sensor based on the change in the temperature-resistance of the thermistor is input into a control unit incorporating a microcomputer, and the water temperature is detected by a water temperature detecting section constituted by a microcomputer. Based on the detected water temperature, a control section also constituted by the microcomputer executes various controls such as a correction in the fuel injection amount (see Japanese Unexamined Patent Publication No. 58-214629).

By the way, the water temperature detection circuit including this kind of the water temperature sensor has been conventionally provided with a self-diagnosis device and a fail-safe device which are constituted by a microcomputer in a software manner (see Japanese Unexamined Patent Publication No. 59-107227).

Specifically, as is shown in the flowchart of FIG. 4, the water temperature is read in response to the signal from the water temperature sensor (F1). Then, it is determined whether or not the water temperature is −30°C or lower or 110°C or higher (F2, F3). If the temperature is between −30°C and 110°C, the water temperature detective circuit is determined as being in a normal state and the water temperature detected by the water temperature detective circuit is utilized for various controls. Contrarily, if the temperature is −30°C or lower (the resistance of the thermistor is large), the water temperature detective circuit is determined as being in an abnormal state such as disconnection. In this case, the water temperature is tentatively determined as being 40°C (F4). If the temperature is 110°C or higher (the resistance of the thermistor is small), the water temperature detective circuit is determined as being in an abnormal state such as short-circuit. In this case, the water temperature is tentatively determined as being 110°C (F5), and various controls are executed based on the tentative water temperature

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for fail-safe control. In either cases where the abnormal states have occurred, a self-diagnosis abnormality (NG) is displayed (F6).

(Problems to be solved by the Utility Model)

However, in the self-diagnosis and fail-safe device of the conventional water temperature detective circuit, the self-diagnosis and fail-safe are not be executed until the circuit is completely disconnected or short-circuited. In the case where the circuit is partially disconnected, this partial disconnection cannot be detected and a fail-safe is not executed. As a result, there arises problem that an engine failure and the like occurs.

For example, when the actual water temperature is 80°C and the thermistor of the water sensor is normal and its resistance value is 300Ω, if a partial disconnection has occurred and the resistance value is reduced to 2.5kΩ, the water temperature is detected as 20°C. In this case, since the actual water temperature cannot be distinguished from 20°C, neither the NG is displayed nor the fail-safe is executed. Therefore, although the actual water temperature is 80°C, the water temperature is determined as 20°C and the fuel injection amount to be corrected based on the water temperature is corrected based on the correction value of 20°C. As a result, an engine failure and the like occurs.

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Under the circumstances described above, an objective of the present utility model is to provide a self-diagnosis and fail-safe device of water temperature detection circuit capable of detecting even a partial disconnection of a water temperature detection circuit to enhance its self-diagnosis ability, and also capable of executing more accurate fail-safe control.

(Means for solving the Problem)

In order to achieve the foregoing objective, as shown in Fig. 1, there are provided water temperature reading means A for reading a water temperature based on a signal from a water temperature sensor 3, change amount calculating means B for calculating a change amount per hour in the read water temperature, determining means C for comparing the change amount with a specified value so as to determine whether or not there is an abnormality, self-diagnosis abnormality displaying means D for displaying a self-diagnosis abnormality when there is an abnormality, and tentative water temperature setting means E for setting a tentative water temperature based on the water temperature of the previous time when there is an abnormality and for outputting the tentative water temperature to the control section.

(Operation)

Specifically, in view of the fact that water temperature does not change for a short period of time (about 20°C/min at the maximum), when the change in the water temperature per hour has exceeded a specified value, self-diagnosis abnormality is displayed. Further, a tentative water temperature is set bated on the previous water temperature and is sent to a control section, and if necessary, the control section executes various controls based on the tentative water temperature.

(Embodiments)

Hereinafter, an embodiment of the present utility model will be described.

FIG. 2 shows a hardware structure.

A microcomputer in a control unit 1 is provided to control a fuel injection made by a fuel injection valve 12 provided on an intake passage 11 in an engine 10. The fuel injection amount (a pulse width of the drive pulse signal) from the fuel injection valve 12 is calculated from the engine operation conditions in a control section formed inside the microcomputer 2. When the fuel injection amount is calculated, the fuel injection amount is corrected based on the water temperature detected by a water temperature detective section also formed inside the microcomputer 2.

In order to detect the water temperature to be used for such a fuel injection amount correction, a water temperature

sensor 3 composed of thermistor is provided against a cooling water passage (water jacket) in the engine 10. The terminal voltage of the water temperature sensor 3 based on the change in the temperature-resistance of the thermistor is input into the microcomputer 2 via an A/D converter 4.

The water temperature detective section in the microcomputer 2 is provided with, as shown in the flowchart of FIG. 3, functions as the water temperature reading means, change amount calculating means, determining means, self-diagnosis abnormality displaying means, and tentative water temperature setting means in a software manner.

A description will be made along the flowchart of FIG. 3. First, the water temperature Tw is read based on the terminal voltage at the water temperature sensor in S1.

Next, in S2, a change amount of the water temperature Tw of this time against the water temperature Twl of the previous time which has been set at the previous time in S9 described later is calculated as follows: $\Delta Tw = \bullet\, Tw - Twl \bullet$.

Then, in S3, the change amount ΔTw is compared with a specified value K (defining that a timer described later is set to 10sec, K=about 3.3°C), and it is determined whether the change amount ΔTw is larger or smaller than the specified value K, that is, whether or not there is an abnormality.

When the change amount ΔTw is the specified value K or smaller, it is determined that there is no abnormality and

the process proceeds to S8. In S8, the read water temperature Tw is sent to the control section as it is, to correct the fuel injection amount based on the read water temperature Tw.

After that, the water temperature Tw of this time is substituted into Twl in order to calculate the change amount of the next time in S9, and a timer is set in S10. When a specified time period has elapsed (for example, 10 sec), the routine from S1 and thereafter is executed again.

When the change amount ΔTw is determined in S3, if the change amount ΔTw exceeds the specified value K, it is determined that there is an abnormality and the process proceeds to S4 where a self-diagnosis NG is displayed. Specifically, a light emitting diode 5 for displaying a result of self-diagnosis lights in response to the output from the microcomputer 2.

Next, the process proceeds from S4 to S5 where it is determined whether or not Tw>Twl, that is, the change direction of the water temperature Tw is determined. If the change is in an increasing direction, the process proceeds to S6 where the specified value K is added to the water temperature Twl of the previous time to set a tentative water temperature Tw. If the change is in a decreasing direction, the process proceeds to S7 where the specified value K is subtracted from the water temperature Tw of the previous time to set a tentative water temperature Tw. After that, in either cases, the process

proceeds to S8 where the obtained tentative water temperature Tw is sent to the control section to correct the fuel injection amount based on the tentative water temperature Tw. Thereafter, in either cases, the process proceeds to S9 and S10 simultaneously in this order, and then the routine from S1 and thereafter is executed again.

As described above, if the change amount in the water temperature per hour exceeds the specified value, the self-diagnosis NG is displayed. As a result, the self-diagnosis ability is enhanced.

In addition, if the change in the water temperature exceeds the specified value, the fail-safe control is executed in such a manner that the fuel injection amount is corrected based on the tentative water temperature which falls within the range of the specified value. Therefore, the control output never changes rapidly, thereby avoiding an engine failure such as engine stop as much as possible.

The above embodiment has described only the case where the fuel injection amount is corrected based on a water temperature. However, it is a matter of course that the present utility model is also applicable to the cases where the idle rotation speed control or ignition control are corrected based on a water temperature. However, it is not necessary to execute all the controls based on the tentative water temperature, and

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alternatively, the correction based on a water temperature itself may be interrupted when an abnormality occurs.

(Effect of the Utility Model)

As described above, according to the present utility model, the self-diagnosis ability of the water temperature detective circuit is enhanced, thereby enabling more accurate self-diagnosis, and in addition, a fail-safe control at the time when an abnormality occurs can be more accurately executed. As a result, there is an effect that an engine failure due to the rapid change in the control output is avoided.

4. Brief Description of the Drawings

FIG. 1 is a functional block diagram showing a structure of the present utility model. FIG. 2 is a hardware structural diagram showing an embodiment of the present utility model. FIG. 3 is a flowchart showing details of the control executed in the embodiment of the present utility model. FIG. 4 is a flowchart of a conventional example.

1: Control unit, 2: Microcomputer, 3: Water temperature sensor, 5: Light emitting diode, 10: Engine, 12: Fuel injection valve, 13: Cooling water passage

Utility model registration applicant

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(FIG. 1)

1: Water temperature sensor

2: Water temperature reading means

3: Change amount calculating means

4: Determining means

5: Self-diagnosis abnormality displaying means

6: Tentative water temperature setting means

7: To control section

8: Microcomputer

(FIF. 3)

1: Water temperature reading

2: Self-diagnosis NG display

3: Output Tw

4: Timer

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Application Number: Sho-59-184323

Application Date: December, 6, 1984

Creator: Hideo Takahashi

Applicant: JEOL,Ltd

Title of the Invention

A SELF-DIAGNOSTIC AND FAIL-SAFE UNIT FOR WATER TEMPERATURE DETECTING CIRCUIT FOR INTERNAL COMBUSTION ENGINE

Claim:

A self-diagnostic and fail-safe unit for water temperature detecting circuit for internal combustion engine comprising: a water temperature sensor facing an engine cooling water passage for generating an electric signal corresponding to a water temperature; and water-temperature reading means for reading a water temperature based on the signal from the water temperature sensor, wherein a water temperature detecting circuit for internal combustion engine operative to detect a water temperature and to provide various control comprises: variation amount calculating means for calculating a

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per-unit-time amount of variation of the read water temperature; judging means for determining on the presence of abnormality by comparing the amount of temperature variation and a specified value; a self-diagnostic abnormality display means for conducting displaying of self-diagnostic abnormality in the event of abnormality; and dummy water temperature setting means for setting a dummy water temperature based on a preceding water temperature in the event of abnormality and outputting the set dummy water temperature to a control unit.

Brief description of the Drawings

Fig.1 is a function block diagram showing an arrangement of the present device; Fig.2 is a diagram showing a hardware configuration according to one embodiment of the device; Fig.3 is a flow chart representing the content of control according to the embodiment of the device; and Fig.4 is a flow chart showing a conventional example.

1: CONTROL UNIT, 2: MICRO COMPUTER, 3: WATER TEMPERATURE SENSOR, 5: LIGHT EMITTING DIODE, 10: ENGINE, 12: FUEL INJECTOR VALVE, 13: COOLING WATER PASSAGE

FIG.1

3: WATER TEMPERATURE SENSOR

A: WATER TEMPERATURE READING MEANS

B: VARIATION AMOUNT CALCULATING MEANS

C: JUDGING MEANS

D: SELF-DIAGNOSIS/ABNORMALITY INDICATION MEANS

E: DUMMY WATER TEMPERATURE SETTING MEANS

TO CONTROL UNIT

FIG.2

2: MICRO COMPUTER

FIG.3

S1: READ WATER TEMPERATURE

S4: SELF DIAGNOSE AND NG INDICATION

S8: OUTPUT Tw

S10: TIMER

FIG.4

F1: READ WATER TEMPERATURE

F6: SELF DIAGNOSE AND NG INDICATION

JP-U-61-099650 teaches a self-diagnosis and fail-safe apparatus for an engine coolant temperature detecting circuit. Each time coolant temperature is detected, a change of temperature in a unit time is calculated and compared with a reference value. If the calculated temperature change is abnormal, abnormality is indicated, and the previously detected temperature is used for various controls.

JP-U-02-050043 teaches a coolant temperature sensor diagnosis apparatus. When a predetermined time passes after an engine is started, a coolant temperature is detected and compared with a reference temperature, which is predetermined as a lowest limit which the coolant temperature should attain. If the detected temperature is lower than the reference temperature, a coolant temperature sensor is determined as abnormal.

JP-U-02-072343 teaches a coolant temperature detecting apparatus. When an engine coolant temperature is detected as being abnormal, the coolant temperature is estimated as increasing based on the time of operation of the engine after being started, and used in place of the detected temperature.

⑲日本国特許庁（JP）　⑪実用新案出願公開

⑫公開実用新案公報（U）　昭61-99650

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㊹考案の名称　内燃機関における水温検出回路の自己診断及びフェイルセーフ装置

㉑実　願　昭59-184323

㉒出　願　昭59(1984)12月6日

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明　細　書

1．考案の名称

内燃機関における水温検出回路の自己診断及びフェイルセーフ装置

2．実用新案登録請求の範囲

機関冷却水通路に臨んで水温に応じた電気的信号を発生する水温センサと、この水温センサからの信号に基づいて水温を読込む水温読込み手段とを備え、水温を検出して各種制御を行わせる内燃機関の水温検出回路において、読込み水温の時間当りの変化量を算出する変化量算出手段と、その変化量を規定値と比較して異常の有無を判定する判定手段と、異常有りの時に自己診断異常表示を行う自己診断異常表示手段と、異常有りの時に前回の水温に基づいて疑似水温を設定し制御部へ出力する疑似水温設定手段とを設けたことを特徴とする水温検出回路の自己診断及びフェイルセーフ装置。

3．考案の詳細な説明

〈産業上の利用分野〉

本考案は、内燃機関において、機関冷却水温度（以下水温という）を検出しこれに基づいて燃料噴射量補正等の各種制御を行わせる水温検出回路に関し、特にその自己診断及びフェイルセーフ装置に関する。

〈従来の技術〉

従来から、内燃機関においては、機関冷却水通路にサーミスタを利用した水温センサを設け、サーミスタの温度－抵抗変化に基づく水温センサからの信号をマイクロコンピュータ内蔵のコントロールユニットに入力させて、マイクロコンピュータにより構成される水温検出部により水温を検出し、この検出水温に基づき同じくマイクロコンピュータにより構成される制御部で燃料噴射量補正等の各種制御を行っている（特開昭58－214629号公報参照）。

ところで、この種の水温センサを含む水温検出回路には、従来からマイクロコンピュータによってソフトウェア的に構成される自己診断装置及びフェイルセーフ装置を具備させていた（特開昭5

9－107227号公報参照）。

すなわち、第4図のフローチャートに示すように、水温センサからの信号に基づいて水温を読込み（Ｆ１）、その後、その水温が－30℃以下又は110 ℃以上であるか否かを判定し（Ｆ２，Ｆ３）、－30℃と110 ℃の間にあるときは正常とみなして、その水温を各種制御に使用するようにするが、－30℃以下（サーミスタの抵抗大）の場合は、断線等による異常であるとみなして制御用に水温は40℃であると擬制し（Ｆ４）、110 ℃以上（サーミスタの抵抗小）の場合は、ショート等による異常であるとみなして、制御用に水温は110 ℃であると擬制し（Ｆ５）、かかる疑似水温によって各種制御を行わせてフェイルセーフ制御を行うと共に、いずれの異常の場合も自己診断異常（ＮＧ）表示を行わせている（Ｆ６）。

（考案が解決しようとする問題点）

しかしながら、このような従来の水温検出回路の自己診断及びフェイルセーフ装置にあっては、完全に断線又はショートしない限り、自己診断及

びフェイルセーフがなされず、半断線不具合の場合にはＮＧを検出できず、フェイルセーフに入らないため、エンジン不調等が発生するという問題点があった。

例えば実際の水温が80℃で水温センサのサーミスタが正常ならばその抵抗値が300Ωのときに、半断線を生じて抵抗値が2.5 KΩとなった場合、水温は20℃であると検出される。この場合は、実際の水温が20℃の場合と区別できないため、ＮＧ表示も行われず、フェイルセーフにも入らない。したがって、水温が80℃にも拘わらず20℃とみなして、燃料噴射量の水温補正も20℃の補正値で行われるため、エンジン不調等を生じてしまう。

そこで本考案は、水温検出回路の半断線をも検出可能にして自己診断能力を向上させ、かつフェイルセーフ制御もより適正に行うことのできる水温検出回路の自己診断及びフェイルセーフ装置を提供することを目的とする。

〈問題点を解決するための手段〉

本考案は、上記の目的を達成するため、第１図

に示すように、水温センサ３からの信号に基づいて水温を読込む水温読込み手段Ａと、読込み水温の時間当りの変化量を算出する変化量算出手段Ｂと、その変化量を規定値と比較して異常の有無を判定する判定手段Ｃと、異常有りの時に自己診断異常表示を行う自己診断異常表示手段Ｄと、異常有りの時に前回の水温に基づいて疑似水温を設定し制御部へ出力する疑似水温設定手段Ｅとを設けるようにしたものである。

（作用）

すなわち、水温は短時間で変化しないこと（最大で20℃／min 程度）に着目し、時間当りの水温の変化量が規定値を超えた場合に、自己診断異常表示を行い、かつ前回の水温に基づいて疑似水温を設定して制御部に送り、制御部で必要に応じこの疑似水温に基づいて各種制御を行わせるのである。

（実施例）

以下に本考案の一実施例を説明する。

第２図はハードウェア構成を示している。

コントロールユニット1内のマイクロコンピュータ2は、機関10の吸気通路11に設けられた燃料噴射弁12による燃料噴射等を制御すべく設けられており、燃料噴射弁12の燃料噴射量（駆動パルス信号のパルス巾）は、マイクロコンピュータ2の内部に構成される制御部において、機関運転条件から算出され、この算出に際し同じくマイクロコンピュータ2の内部に構成される水温検出部により検出される水温に基づいて燃料噴射量の水温補正が行われる。

そして、この種燃料噴射量補正のための水温の検出のため、機関10の冷却水通路（ウォータジャケット）13に臨ませてサーミスタからなる水温センサ3を設け、サーミスタの温度－抵抗変化に基づく水温センサ3の端子電圧をA／D変換器4を介してマイクロコンピュータ2に入力させてある。

ここで、マイクロコンピュータ2の水温検出部には、前記の水温読込み手段，変化量算出手段，判定手段，自己診断異常表示手段，疑似水温設定手段としての機能が第3図のフローチャートに示

される如くソフトウェア的に備えられている。

第3図のフローチャートに従って説明すると、先ずＳ１で水温センサ３の端子電圧に基づいて水温Ｔｗを読込む。

次にＳ２で後述するＳ９で前回セットされた前回の水温Ｔｗℓに対する今回の水温Ｔｗの変化量ΔＴｗ＝｜Ｔｗ−Ｔｗℓ｜を算出する。

次にＳ３でその変化量ΔＴｗを規定値Ｋ（後述するタイマーを10sec とした場合、Ｋ＝3.3 ℃程度）と比較し、その大小すなわち異常の有無を判定する。

変化量ΔＴｗが規定値Ｋ以下のときは、異常無しと判定して、Ｓ８へ進み、読込み水温Ｔｗをそのまま制御部へ送って、読込み水温Ｔｗに基づいて燃料噴射量の水温補正を行わせる。

その後、Ｓ９で次回の変化量の算出のため今回の水温ＴｗをＴｗℓに代入し、Ｓ10でタイマーをセットして所定時間（例えば10sec）後に再びＳ１からのルーチンを実行させる。

Ｓ３での変化量ΔＴｗの判定において、変化量

ΔＴｗが規定値Ｋを超えたときは、異常有りと判定して、Ｓ４へ進み、自己診断ＮＧ表示を行う。具体的にはマイクロコンピュータ２からの出力で自己診断結果表示用の発光ダイオード５を点灯させる。

次にＳ４からＳ５へ進んで、Ｔｗ＞Ｔｗℓであるか否か、すなわち水温Ｔｗの変化の方向を判定し、増大方向の場合はＳ６へ進んで前回の水温Ｔｗℓに規定値Ｋを加算して、疑似水温Ｔｗを設定し、減少方向の場合はＳ７へ進んで前回の水温Ｔｗから規定値Ｋを減算して、疑似水温Ｔｗを設定し、いずれの場合もその後はＳ８へ進んでこの疑似水温Ｔｗを制御部へ送り、この疑似水温Ｔｗに基づいて燃料噴射量の水温補正を行わせる。以降は同時にＳ９，Ｓ10を経て再びＳ１からのルーチンを実行させる。

このように時間当りの水温変化量が規定値を超えた場合に自己診断ＮＧ表示を行うようにすることで、自己診断能力を向上できる。

また、規定値を超える水温変化があった場合、

燃料噴射量の水温補正は規定値の範囲内の疑似水温によって行うようにフェイルセーフ制御するため、制御出力が急激に変化せず、エンスト等のエンジン不調を極力回避することができる。

尚、以上では燃料噴射量の水温補正についてのみ述べたが、アイドル回転数制御や点火制御等の水温補正についても適用できることは勿論である。しかし、すべての制御を疑似水温によって行う必要はなく、異常時には水温補正そのものを停止させるようにしてもよい。

〈考案の効果〉

以上説明したように本考案によれば、水温検出回路の自己診断能力が向上し、より確実な自己診断を行うことができると共に、異常時のフェイルセーフ制御もより適正に行うことができ、制御出力が急変することによるエンジン不調等を招くことがなくなるという効果が得られる。

4．図面の簡単な説明

第1図は本考案の構成を示す機能ブロック図、第2図は本考案の一実施例を示すハードウェア構

成図、第3図は同上の制御内容を示すフローチャート、第4図は従来例のフローチャートである。

1…コントロールユニット　2…マイクロコンピュータ　3…水温センサ　5…発光ダイオード　10…機関　12…燃料噴射弁　13…冷却水通路

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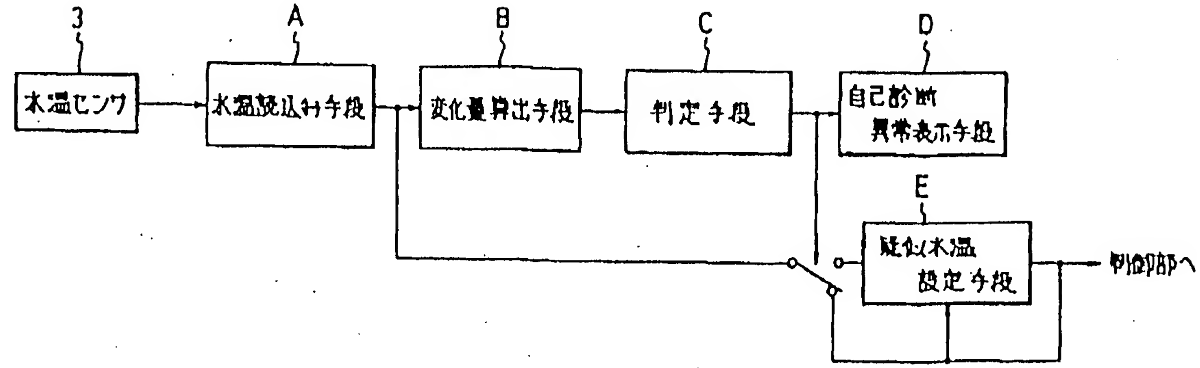
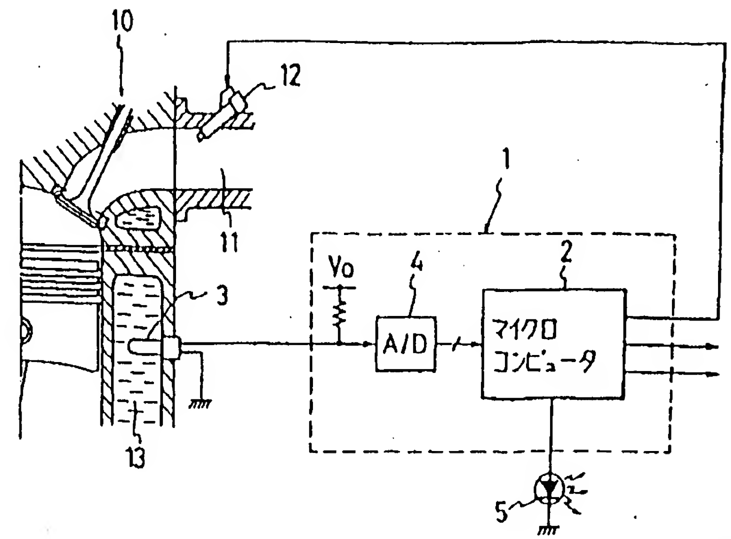
第 1 図



第 2 図



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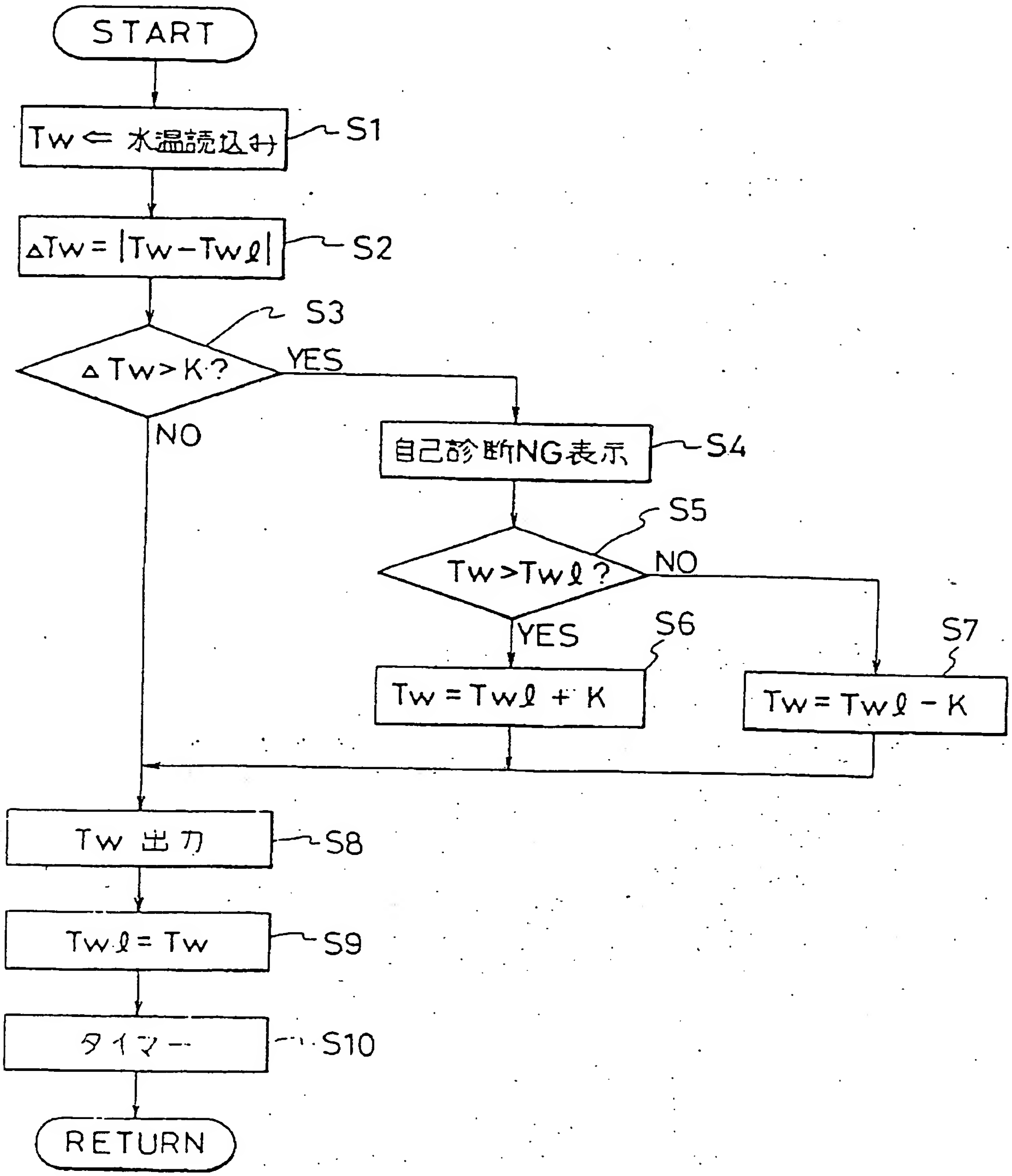
第3図



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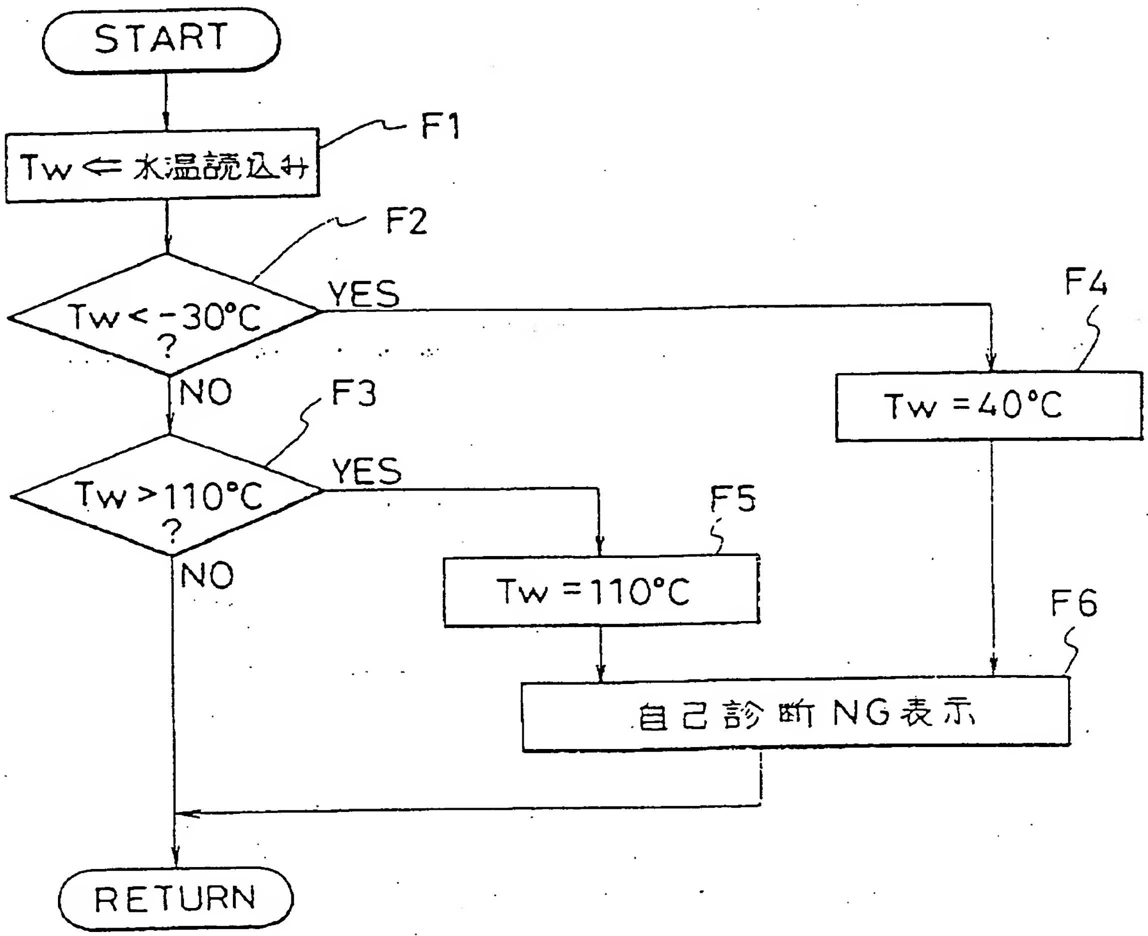
第 4 図



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